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Abstract

Burn-out in subcooled forced convection boiling of polyphenyls

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Since 1961 T.N.O. has been carrying out an extensive research program on the influence of liquid velocity, degree of subcooling and liquid composition on the critical heat flux of polyphenyls flowing upward through a round stainless steel tube heated by the Joule effect.

A description of the test loop is given.

Results are reported on a great number of runs with terphenyl mixtures pressurized by direct contact with nitrogen. These results are well correlated by an equation of the type:

$$\Phi = a + b \cdot G + c \cdot G^{\frac{3}{4}} \cdot \Delta t_s$$

(Φ, critical heat flux; G, mass velocity; Δt_s, degree of subcooling).

The values of the coefficients will be given for the following compositions:
diphenyl 1 wt.%, o-terphenyl 14-16 wt.%, m-terphenyl 79-81 wt.%, p-terphenyl 3-5 wt.%.
diphenyl 1 wt.%, o-terphenyl 64-66 wt.%, m-terpenyl 31-33 wt.%, p-terphenyl 2-4 wt.%.

Parameters as for instance the degree of subcooling are based on the conditions at the outlet of the test tube, i.e. close to the location of burn-out.

The heat flux at the moment at which a sharp increase of the resistance of the test tube is indicated by a burn-out detector is interpreted as the real burn-out heat flux. Some tests in which the test tube was damaged by effecting real burn-out showed this to be permissible.

After these measurements on terphenyls under nitrogen,

the loop has been modified in such a way that liquid and pressurizing medium are separated from each other in a diving bell by molten solder. This enables the study of the separated effects of low-boilers and gases.

Results are presented on terphenyls containing no volatile components and on the effects of increasing concentrations of nitrogen, benzene and diphenyl. These results are interpreted on the basis of the degree of subcooling as derived from the experimentally determined vapour pressure curves. For this purpose a vapour pressure apparatus was developed permitting the accurate measurements of vapour pressure as a function of temperature and composition of mixtures of terphenyls and very volatile substances. This apparatus, which is connected permanently to the test loop, is characterized by the possibility of measuring under the conditions of a very small vapour space, as a consequence of which changes of the liquid composition are avoided.

To obtain equilibrium conditions the liquid may be stirred during the measurement.